A STUDY OF DESIGN SPECIFICATIONS FOR STEEL BRIDGES

BY

KUANG HAN CHU
B.S., National Central University (China), 1942
M.S., University of Illinois, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
ENGINEERING IN THE GRADUATE COLLEGE
OF THE UNIVERSITY OF ILLINOIS,
1950

URBANA, ILLINOIS
1950

A STUDY OF DESIGN SPECIFICATIONS FOR STEEL BRIDGES

BY

KUANG HAN CHU
B.S., National Central University (China), 1942
M.S., University of Illinois, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
ENGINEERING IN THE GRADUATE COLLEGE
OF THE UNIVERSITY OF ILLINOIS,
1950

URBANA, ILLINOIS
1950

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Thomas C. Shedd, Professor of Structural Engineering at the University of Illinois, for encouragement, constructive criticism and helpful suggestions.

Acknowledgment is also made to Professor James G. Clark for permission to use his collection of old American specifications for bridges. The writer is also indebted to Dr. M. W. Jackson for his assistance in finishing the first draft and to Mr. N. Khachaturian for his help throughout the preparation of the final draft.

R. UNIV. BIBLIOTHEEK LEIDEN

A STUDY OF DESIGN SPECIFICATIONS FOR STEEL BRIDGES

The purpose of this thesis is to make a study of a number of important design rules for steel bridges along the following lines: (i) to trace so far as possible the origin and development of the rules, (ii) to determine their fundamental bases, (iii) to make a general survey of the extent of our present knowledge about them, (iv) to provide material for future development and (v) to compare the practice in the United States with that of other countries.

The investigations of this study are based mainly on the design rules up to 1947 given in the "Specifications for Steel Railway Bridges" published by the Amercian Railway Engineering Association (A.R.E.A.). The A.R.E.A. rules are chosen as the main bases of study because during various stages of their development, they have been widely used and have had a great influence in the formulation of design rules given in other specifications for steel bridge design in the United States.

The design rules given in the A.R.E.A. "Specifications for Steel Railway Bridges" are limited for the purposes of this thesis to steel bridges (i) of fixed* spans, (ii) with moderate span lengths (at present not to exceed 400′) and (iii) of ordinary types of simple truss or girder spans. However, in order to clarify certain points, related rules which go beyond these limitations may be introduced.

Almost all the A.R.E.A. rules have been evolved from old specifications for wrought iron or steel bridges issued individually by American engineers and railroad or bridge companies. The original provisions of many of the A.R.E.A. rules have been pointed out in the A.R.E.A. publications. However, there are many rules whose origin has not been identified in the literature. A search of these original clauses was made by the writer in a collection of old American specifications gathered by Professor J. G. Clark† and the information thus obtained is presented in the paper. Since Professor Clark does not regard his collection as absolutely com-

---

* The A.R.E.A. also issues specifications for movable bridges but they have not been reviewed in this thesis.

† Mr. Clark is a Professor of Civil Engineering at the University of Illinois. A bibliography of the main part of this collection and a summary of some of the early specifications are given in his thesis "A Study of the History for the Design of Iron and Steel Bridges Prior to 1905" in 1939. A supplement to the bibliography was prepared later by Professor Clark.

plete, there may be clauses which have escaped the writer's notice; nevertheless, the information herein should have some merit in tracing the course of evolution.

Design rules given in other "specifications" issued by the A.R.E.A. or other engineering associations, societies or administrations in the United States, Great Britain, France and Germany are introduced mainly for comparative study. However, certain rules in these specifications which seem to have real importance have been discussed more fully.

Some limitations in the scope of this thesis have been found necessary because of the vast amount of material involved. The design rules for steel bridges are based on a knowledge of an extremely broad field, and this knowledge represents some two hundred years of theoretical study, over one hundred years of experimental research and long experience in shop and field practice. Some hint of the vast amount of material involved can be seen from the fact that E. H. Salmon's book "Columns" lists 376 articles up to 1920 and for only that one topic. The total number of books and articles related to steel bridge design runs to thousands. It would take a life time and more than one formidable volume to present a thoroughly comprehensive treatment of the subject.

Due to limitations of space and time, some design rules of less importance have been omitted. Moreover, since there has been no final or exact method developed for determining permissible unit stresses, a discussion of this matter has been omitted, although an extensive study of the subject has been made, and some discussion of relative values for different combinations of loads has been presented.

In order to present a picture of the origin, development and bases of particular rules as well as our present knowledge about them and to provide material for their future improvement, brief notes on published articles related to them are given in the text and selected references are listed at the end of the paper. It is believed that the references, approximately four hundred items, are among the most illuminating sources of information. The writer does not claim completeness; however, he believes that they provide sufficient background for a satisfactory understanding and evaluation of the widely used design rules for steel bridges.

In the discussions, some hints are given as to the limitations of some of the rules and important theories or experimental results

which form or are closely related to their bases. An attempt was made to discuss in detail all phases of the design rules, but due to the above noted limitations as to time and space it was necessary greatly to abridge the presentation after a great amount of material had been gathered.

Definitions are given by the writer for some of the terms for which no satisfactory definitions have been found. He hopes that these definitions may help to clarify some of the ambiguities in bridge design specifications.

The Table of Contents is as follows:

CHAPTER I—Introduction

1A. Preliminary Remarks
1B. Necessity of the Study
1C. Purpose and Scope of this Study
1D. Notes on Appendices and Abbreviations

CHAPTER II—Historical Sketch of the Development of Steel Bridges and Specifications for Their Design In the United States and Abroad

2A. Development of Steel Bridges and the Scientific Bases for Their Design (up to the end of 19th century)
2B. Early Development of Steel Bridges and Design Specifications in the United States (up to 1905)
2C. The Work of A.R.E.A.
2D. The Work of A.S.C.E., A.A.S.H.O. and A.W.S.
2E. Foreign Contributions and Specifications

CHAPTER III—General Features of Design

3A. Spacing of Trusses, Girders and Stringers
3B. Depth Ratio

CHAPTER IV—Loads and Forces

4A. Live Load
4B. Distribution of Live Loads
4C. Impact
4D. Wind Force
4E. Longitudinal Force
4F. Centrifugal Force

CHAPTER V—Some Articles Concerning Allowable Stresses

5A. Secondary Stresses
5B. Design for Fatigue
5C. Provision for Future Increase in Loading
5D. The Allowable Stresses for Members Subject to Bending Moments as well as Axial Loads
5E. The Allowable Stresses for Different Combinations of Loads and Forces

CHAPTER VI—Columns

6A. Column Theories, Experiments and Design Formulas
6B. Design of Lacing
6C. Design of Stay Plates

CHAPTER VII—Buckling of Plates

7A. Cover Plates and Web Plates in Columns
7B. Outstanding Flanges of Columns or Girders
7C. Webs of Plate Girders

CHAPTER VIII—Concluding Remarks

APPENDIX I—Specifications

APPENDIX II—Bibliography

VITA

Kuang-han Chu was born November 13th, 1919, in Kashan, Chekiang, China. He had his elementary school education there and his high school education in the Provincial Hangchow Senior Middle School in Hangchow, Chekiang. He entered the National Central University in Nanking in July, 1936, to study Civil Engineering. One year later the outbreak of the Sino-Japanese War interrupted his college life. He resumed his study in July, 1939, in the same University, after it had been moved to Chungking, and graduated there in July, 1942, with the degree of Bachelor of Science in Civil Engineering.

His professional experience embraces the design of highway bridges in the Bureau of Highways from July, 1942, to September, 1943; teaching in National Central Institute of Technology, September, 1943, to April, 1945; and checking line locations in the Bureau of Railroad Surveying of the Ministry of Communications April, 1945, to March, 1946. In April, 1946, he was sent by the Chinese Ministry of Education to pursue further studies in the United States. He entered the University of Illinois at the end of April, 1946, and received the degree of Master of Science in Civil Engineering in February, 1947. He was appointed a Fellow in the Department of Civil Engineering in the school year 1947-1948 and a Special Research Assistant from September, 1948, to February, 1949. He is a Member of Sigma Xi and a Junior Member of The American Society of Civil Engineers.

Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41549816_0120